

A comparative study of internal fixation and prosthesis replacement for radial head fractures of Mason type III

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Abstract Although several treatment options for radial head fractures are available, no clear solutions exist. In this study we therefore compare open reduction and internal fixation (ORIF) with bipolar radial head prosthesis replacement in treatment of radial head fractures of Mason type III. Cement stem and bipolar radial prosthesis were used to treat 12 fresh cases and two old cases of Mason type III radial head fracture. As a control group, another eight cases of radial head type III fracture were treated with ORIF with cannulated screws and Kirschner (K) wires. The 14 patients who received radial head prosthesis replacement were followed-up for 15.9 months (range 10–27 months). According to elbow functional evaluation criteria by Broberg and Morrey, we found excellent results in nine cases, good in four, and fair in one. Mean follow-up of the eight cases in the ORIF group was 14 months (range 10–21 months), with good results in one case, fair in four, and poor in three. The result was good or excellent in 92.9% of prosthesis replacement patients and in 12.5% of ORIF patients. This difference is statistically significant ($P=0.0004$; Fisher's exact test). We concluded that bipolar radial head prosthesis replacement is better than ORIF in treatment of Mason type III radial head fracture.

Résumé Malgré l'existence de plusieurs options thérapeutiques concernant les fractures de la tête radiale aucune

solution parfaitement claire n'émerge. Dans cette étude nous avons comparé la technique réduction et fixation interne (ORIF) avec la prothèse de tête radiale bipolaire, ceci pour les fractures de tête de type III de Mason. La prothèse de tête radiale bipolaire cimentée a été utilisée dans le traitement de 12 fractures fraîches et de 2 fractures anciennes de type Mason III. Un groupe contrôle de 8 fractures, toujours du groupe III ont été traitées par la technique ORIF avec vis canulées et broches de Kirschner. 14 patients qui ont bénéficié de cette mise en place ont été suivis pendant 15,9 mois (de 10 à 27 mois). Ces patients ont été évalués selon les critères de Broberg et Morrey, il s'agit d'une évaluation fonctionnelle. Le résultat a été considéré comme excellent dans 9 cas, bon dans 4 cas et médiocre dans 1 cas. Le suivi moyen des 8 cas traités par ostéosynthèse a été de 14 mois (de 10 à 21 mois) avec un seul bon résultat, un résultat passable dans 4 cas et 3 mauvais résultats. Les résultats sont bons et excellents dans 92,9% des sujets prothésés et seulement dans 12,5% des sujets ostéosynthésés. Cette différence est statistiquement significative ($P=0.004$, selon le test de FISHER). Nous pouvons en conclure que la prothèse bipolaire de tête radiale est bien supérieure au traitement par ostéosynthèse dans les fractures de type III de Mason.

Introduction

Radial head fractures occur in about 17–19% of cases of elbow trauma and account for 33% of elbow fractures [2]. In general, the treatment of radial head fractures is based on the fracture type and the presence of any associated injury. The most commonly used classification of radial head fracture is proposed by Mason [12]. There is little question that a Mason type I fracture, because of nondisplacement, should

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be managed without surgery. In managing displaced radial head fractures (Mason type II), improved techniques and more versatile instrumentation have helped make preservation more feasible. Excellent results can be achieved with open reduction and internal fixation (ORIF) [13]. Most clinicians have personally experienced disappointment with the treatment of radial head fracture of Mason type III.

The surgical options for complex fractures include ORIF, excision, and replacement of the head. Excision of the radial head for fracture has a high complication rate [10]. Several significant complications are associated with radial head excision such as symptoms at the wrist, increased elbow valgus, degenerative arthritis, and so on [2]. ORIF and radial head prosthesis replacement have been used in the treatment of radial head fractures of Mason type III in recent years. The management of this issue remains a matter of controversy. This study was conducted to compare ORIF with radial head prosthesis replacement in the treatment of radial head fracture of Mason type III.

Materials and methods

Twenty-two consecutive patients were treated with radial head replacement or ORIF for radial head fractures of Mason type III between April 2002 and February 2006. After patients were cleared for admission into the study, the objectives of the study and the randomisation were explained to them and an informed consent was signed. The replacement group consisted of 14 patients, eight men and six women, who received treatment of the fracture with radial head prosthesis (Tornier Inc., France) replacement. The ORIF group consisted of eight patients, five men and three women, who received treatment of the fracture with ORIF. The average age was 37.4 years in the replacement group and 40.1 years in the ORIF group ($P>0.05$; rank sum test). In the replacement group, 12 patients had fresh fractures and two patients had old fractures. All patients who had fresh fractures were treated within 4–17 days after injury, and the two old fracture cases were treated after 12 and 18 months of injury. The difference in time from injury to operation between the two groups isn't statistically significant ($P>0.05$; rank sum test).

Surgical techniques

Patients in the replacement group received local anesthesia and were placed in a supine position with affected extremity in abduction with the use a pneumatic tourniquet. The posterolateral approach was regularly used and the annular ligament was exposed through a posterolateral capsular incision. The annular ligament was incised transversely, and the neck of the proximal radius was

osteotomised on the plane of 5 mm above the biceps tuberosity. The proximal medullary canal of the radius was then prepared with burrs or rasps to accept the implant. After the use of a trial prosthesis has demonstrated satisfactory contact between the capitulum and the prosthesis, and a good fit in the radial medullary canal is found, the final Tornier stem is inserted. The definitive prosthesis is cemented. Finally, a fit bipolar radial articular surface prosthesis was implanted. The annular ligament was repaired with nonabsorbable sutures (Ethicon, Johnson & Johnson Company, Europe). If no associated injuries were present, passive rehabilitation was begun 48 hours postoperatively. Celecoxib capsules (Celebrex, Pfizer Pharmaceuticals Limited, America) therapy (200 mg every 12 hours for a mean of six weeks) was used for the group.

Patients in the ORIF group were treated with cannulated screws and K wires. And all eight patients were immobilised in plaster for four weeks. Rehabilitation began when plasters were removed four weeks after surgery.

Statistical analysis

Differences between the two groups, in patient's age and the time from injury to operation, were compared using the rank sum test. For the treatment result, differences between the two groups in satisfactory rate were compared using Fisher's exact test. In all cases, a p value of 0.05 was assumed to denote statistical significance. All statistical analyses were performed using SAS vs 8.20 (SAS Institute Inc, USA).

Results

The 14 patients who had received radial head replacement were followed up for an average of 15.9 months (range 10–27 months). According to elbow functional evaluation criteria by Broberg and Morrey [5], we found excellent results in nine cases, good in four, and fair in one. No radial nerve injuries were detected postoperatively. The patient who had fair elbow function had a dysfunctional elbow following failure of internal fixation before replacement. There were various levels of heterotopic ossification in three cases. As a comparison, mean follow-up of the eight cases in the ORIF group was 14 months (range 10–21 months), with good results in one case, fair in four, and poor in three. Bone nonunion and bone absorption were found in four cases with K-wire loosening. The outcome was considered to be satisfactory if the result was good or excellent and unsatisfactory if it was fair or poor [5]. The outcome was satisfactory in 92.9% of prosthesis replacement patients and in 12.5% of ORIF patients. This difference is statistically significant ($P=0.0004$; Fisher's exact test).

Discussion

The poor earlier results of radial head fracture were probably due to an inadequate understanding of anatomy, less refined techniques, and possibly, the perception of universal satisfaction with simple resection [2]. Because today's standards demand a greater degree of satisfactory function, ORIF is being widely used, and radial head prosthesis replacement is used in selected cases. Some authors believe that the radial head is not only important for humeroradial joint [1, 14], but also for the stability of distal ulnoradial joint. In fractures of the radial head, especially complicated with forearm soft tissue injury, proximal migration of radius appears frequently and results in wrist strength weakening and chronic elbow pain. In addition, radial head fracture is often associated with other fractures of elbow joint and related elbow instability. Radial head replacement is indicated for irreparable radial head fractures associated with elbow instability. The prosthesis may provide some element of stability, allowing early rehabilitation. Some authors believe that an arthroplasty with

radial head prosthesis, at least in the short term, is a safe and effective option for the treatment of severe radial head fractures [4, 6, 7, 11].

Treating comminuted radial head fractures with ORIF or prosthetic replacement remains a matter of controversy. Boulas and Morrey [3] considered that range of motion and strength of elbow measurements were similar, except for grip strength, which was significantly better for ORIF patients compared to excision or silastic replacement groups. Patients with ORIF had the best clinical scores with minimal radiographic changes. If possible, ORIF of displaced radial head fractures appears to provide the best functional result. While Rizzo and Nunley [13] believed that in cases (Mason type III–IV) in which ORIF is impossible, prosthetic replacement of the radial head is a sound alternative. Successful results have been obtained with arthroplasty, and with second-generation modular systems, the facility of performing this procedure should increase. Treatment of fractures of the capitulum have also benefited from improved fixation systems. Inagaki [9] reported the effects of a radial head component on total



Fig. 1 a Left radial head fracture (Mason type III). b Replacement by cement stem bipolar radial head prosthesis. c Clinical follow-up at 1 year shows excellent prosthesis location. d–g Function of the elbow restored after one year

elbow arthroplasty kinematics and stability using an anatomical design unlinked total elbow prosthesis. An electromagnetic tracking device recorded motion and varus and valgus displacements under various conditions in ten cadaveric elbows. They concluded that radial head prosthesis replacement is necessary for irreparable radial head fractures. A metal radial head replacement restored elbow stability when fracture of the radial head occurred in combination with dislocation of the elbow, rupture of the medial collateral ligament, fracture of the proximal ulna, and/or fracture of the coronoid process. Clinical results suggest that this functions well on a long-term basis [8]. The patients' pre-existing wrist pain disappeared after insertion of the radial head prosthesis, suggesting that the radial head prosthesis can restore the anatomical structure of ulnoradial joint and improve function of wrist joint [15].

In this study the eight patients' fractures in the ORIF group were fixed with cannulated screws and K wires. The fractures were reduced anatomically in radiography. However, because the radius heads were comminuted fractures and the fragments lost blood supply, complications such as nonunion and K-wire loosening still appeared postoperatively. Four weeks of plaster immobilisation after surgery, even after prolonged exercise rehabilitation, also led to elbow function disturbance. Four of eight cases in this group had nonunion and migration of fractured fragment, two cases had K-wire loosening, and one case needed a second prosthetic replacement.

There are several issues worth attention in the procedure of prosthetic replacement. First, the osteotomy plane of the proximal radius determines whether the prosthesis fits or not. The osteotomised length of the proximal radius must be adjusted accordingly. If it is too short, the implanted prosthesis will be tight. If it is too long, the implanted prosthesis will be unable to make contact with the capitellum and lose its advantage. The author's preferred plane is 5 mm above the radial tuberosity. Several radial prosthesis trial and revision insertions may be necessary to ensure a snug fit. Second, good axial alignment of the radial prosthetic stem should prevent eccentric rotation of the radius during pronation/supination. The neck of the radius makes an angle of approximately 15° opposing the radial tuberosity with the long axis of the proximal radius. The prosthetic stem should be in accord with the angle. Finally, management of ligament and soft tissue is a critical step, which will determine the results of the surgery. Reconstruction of the annular ligament is a precondition for brachioradial joint stabilisation. We firmly reconstructed the annular ligament with a heavy (#5) nonabsorbable suture. Medial and lateral collateral ligament injuries and articular capsule injuries, in our experience, should be reconstructed

whenever possible. Furthermore, early mobilisation for the restoration of elbow function and range of motion are important. In this study, elbow function of the cases fixed with plaster casts was decreased to some extent, whereas the patients who were mobilised early had better recovery.

Conclusion

We conclude that cement stem and bipolar radial head prosthesis replacement is better than ORIF in treatment of Mason type III radial head fracture. The fracture fragments lose blood supply and are liable to necrosis. Prosthesis replacement can better restore the stability, flexion and extension of the elbow, and the rotational motion of the forearm (c.f. Fig. 1). However, longer-term follow-up will be required in order to come to more definitive conclusions regarding the use of the bipolar radial head prosthesis.

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